United States
Department of
Agriculture

**Forest
Service**

Forest
Products
Laboratory

Dividends From Wood Research

Recent Publications

January–June 1992

Explanation and Instructions

"Dividends From Wood Research" is a semiannual listing of recent publications resulting from wood utilization research at the Forest Products Laboratory (FPL). These publications are produced to encourage and facilitate application of Forest Service research. This issue lists publications received from the printer by the FPL Publications Section between January 1, 1992, and June 30, 1992.

Each publication listed in this brochure is available through at least one of the sources below. For each entry in the brochure, we indicate the primary source for that publication and show you how to obtain a copy.

Available from FPL (indicated by an order number before the title of the publication): Quantities limited. Circle the order number on the blank at the end of the brochure and mail or FAX the blank to FPL.

Available through sales outlets (indicated by the name of the outlet and, when available, price information): Major sales outlets are the Superintendent of Documents, the National Technical Information Service (NTIS), and various private publishers. Order directly from the outlet.

Available through libraries: Research publications are available through many public and university libraries in the United States and elsewhere. U.S. Government publications are also available through many Government Depository Libraries. Check with a major library near you to determine availability.

List of Categories

Publications are listed in this brochure within the following general categories:

Biodeterioration and Protection

1. Effect of Weathering of New Wood on the Subsequent Performance of Semitransparent Stains

Arnold, Martin; Feist, William C.; Williams, R. Sam.
1992. Forest Prod. J. 42(3): 10–14.

The objectives of this study were to determine effects of short-term preweathering of wood on spreading rates and durability (outdoor exposure) of semitransparent penetrating stains applied to preweathered wood. A secondary objective was to evaluate image analysis techniques for measuring stain durability.

2. Early Detection of Brown-Rot Decay in Southern Yellow Pine Using Immunodiagnostic Procedures

Clausen, C.A.; Green, F., III; Highley, T.L.
1991. Wood Sci. Technol. 26: 1–8.

This report compares ELISA, immuno-dot blot, and particle agglutination assays for the early detection of six brown-rot fungi on southern yellow pine (*Pinus* sp.) and correlates these methods with wood-block weight loss.

3. Why Bother to Paint Wood Before It Weathers?

Feist, William C.; Williams, R. Sam.
1991. Am. Paint Coatings J. Nov. 18. 3 p.

Outdoor weathering of unprotected wood can cause severe surface degradation. This weathering before coating (called preweathering) can lead to chemical and physical changes on the wood surface that weaken the future coating/wood interface. Research results from the Forest Products Laboratory and several other studies show that whether outdoor exposed wood is to be painted, stained, or finished in any manner, preweathering for as little as 4 weeks is detrimental to the service life of the finish. Recommendations are given for preweathering times for treated and untreated wood.

4. Wood Decay by Brown-Rot Fungi: Changes in Pore Structure and Cell Wall Volume

Flournoy, Douglas S.; Kirk, T. Kent; Highley, T.L.
1991. Holzforschung. 45: 383–388.

The objectives of this study were to determine the following: (1) the pore volume in sound wood cell wall available to molecules of

different size; (2) whether attack by a brown-rot fungus, during which cellulose is depolymerized, results in a sudden increase in cell wall volume; and (3) whether this decay opens up the pore structure of the cell wall in a manner that allows access by large molecules.

5. Role of Oxalic Acid in Incipient Brown-Rot Decay

Green, Frederick, III; Larsen, Michael J.; Winandy, Jerrold E.; Highley, Terry L.
1991. Mater. Org. 26(3): 191-213.

The objective of this research was to determine the role of acid produced during early brown-rot decay by two isolates of *Postia placenta*, MAD 698 and ME 20. The results of direct pH measurement in wood blocks demonstrated a rapid decrease in pH to about 1.7 within 7 days by MAD 698. Estimation of oxalic acid production in vitro in woody substrates correlated with decreased pH. The results of in vitro treatment of Southern Pine blocks and cellulose with oxalic acid showed that acid can break down hemicellulose and depolymerize cellulose to a degree of polymerization of about 200 in 7 days. The authors concluded that low-molecular-weight acids are important in the initiation of brown-rot decay.

6. Treatability of Native Softwood Species of the Northeastern United States

Gjovik, Lee R.; Schumann, David R.
1992. USDA Forest Serv. Res. Pap. FPL-RP-508. 20 p.

In this study, whether wood from dead (defoliated) or dying (partially defoliated) trees of these species could be treated successfully with ammoniacal copper arsenate or chromated copper arsenate was studied. The relationship of treatability to growth rate in three other softwood species (red pine, white pine, and eastern larch), which vary from slow grown (naturally grown) to fast grown (plantation grown), was also studied.

7. In-Place Treatments for Preventing Decay in Waterfront Structures

Highley, Terry L.; Scheffer, Theodore C.
1992. Mater. Org. 26(1): 1-11.

This paper describes experiments established initially in 1969 to determine the potential of (1) in-place treatment of deck planks with fungicides for preventing decay in untreated wood or pressure-treated wood with checks that penetrate the zone of preservative treatment and (2) cap and fungicidal treatments for protecting the cut tops of newly installed piling from decay. Previous papers reported details of the experimental design and observations through 15 years of exposure.

8. Effects of Acidic Deposition on Painted Wood: A Review

Williams, R. Sam.
1991. J. Coatings Technol. 63(800): 53-73.

Acidic deposition has captured the attention of many researchers during the last decade and considerable knowledge has been gained in many disciplines including forestry, limnology, atmospheric sciences and materials science. The study of the degradation of materials by acidic deposition has included the effects on wood, paint, and painted wood. The literature pertinent to the effects of acidic deposition and its precursors on these materials is critically reviewed. The subjects include transport properties of paints and polymers, the reactions of acids with paint components, and the degradation of wood. The research on acidic effects on paint degradation leaves many questions unanswered and the review forms the basis for future research recommendations.

Energy

9. Liquid Fuels From Wood—Ethanol, Methanol, Diesel

Zerbe, John I.
1992. World Resource Review. 3(4): 406-414.

This paper reviews progress that has been made and the suitability of different types of liquid fuels from wood in today's unsettled global economic and international trade situation. Estimates of the available domestic supply and cost of wood for use in production of liquid fuels are also given.

Engineering Properties and Design Criteria

10. Environmental Effects on the Load-Duration Behavior of Structural Lumber

Fridley, Kenneth J.; Tang, R.C.; Soltis, Lawrence A.
1991. In: Proceedings of the 1991 International timber engineering conference; 1991 September 2-5; London. London: TRADA: 4.180-4.187. Vol. 4.

A comprehensive investigation was conducted to define the effects of environmental loadings on the load-duration behavior of structural lumber. The independent and combined effects of constant and cyclic temperature and relative humidity were investigated. The goal of the research was to rationally and systematically observe and quantify any environmental effects on the load-duration behavior. An overview of the research effort is presented.

11. Hygrothermal Effects on Mechanical Properties of Lumber

Fridley, Kenneth; Tang, R.C.; Soltis, Lawrence A.
1992. J. Struct. Eng. 118(2): 567-581.

The focus of this paper is to present the mechanical properties of a certain sample of structural lumber as a function of temperature and moisture content. Furthermore, the observed modes of failure as a function of temperature and moisture content will be addressed. The characterization of the lumber sample was required as part of a parent study into environmental effects on the long-term load-carrying behavior of structural lumber (i.e., the load-duration phenomenon), parts of which have been reported. The goal of this study was to quantitatively describe the mechanical properties of the sample with special reference to possible environmental effects and to develop a predictive model that could predict the strength and stiffness of an individual piece of lumber from a sample knowing only its relative rank in the cumulative density functions of strength and stiffness, respectively.

12. Moisture Effects on Load-Duration Behavior of Lumber. Part II. Effect of Cyclic Relative Humidity

Fridley, Kenneth J.; Tang, R.C.; Soltis, Lawrence A.
1991. Wood Fiber Sci. 24(1): 89-98.

The effect of cyclic moisture conditions on the load-duration behavior of structural lumber is presented. Select Structural and No. 2 Douglas-fir nominal 2 by 4 specimens were tested in bending in two cyclic relative humidity (RH) environments: 35 to 95 percent RH on 24- and 96-hour cycles. A constant temperature of 73°F was maintained in both tests. Constant bending loads based on the 15th percentile of the static strength distributions for each grade at 73°F and 50 percent RH were used to load the beams. The load-duration behavior in the two cyclic RH environments is compared to previously reported results observed from three constant RH environments (35, 50, and 95 percent RH at 73°F).

13. Hygrothermal Effects on Load-Duration Behavior of Structural Lumber

Fridley, Kenneth J.; Tang, R.C.; Soltis, Lawrence A.; Yoo, Chai H.
1992. J. Struct. Eng. 118(4): 1023-1038.

This paper draws upon those previously reported results, further illustrates the effect of temperature and moisture content on load-duration behavior with additional data, and develops a complete load-duration model that rationally includes temperature and moisture effect.

14. State-of-the Art Report on Duration-of-Load Research for Lumber in North America

Karacabeyli, Erol; Soltis, Lawrence A.
1991. In: Proceedings of the 1991 International timber engineering conference; 1991 September 2-5; London. London: TRADA: 4.141-4.155. Vol. 4.

This paper provides an overview of duration-of-load research for lumber in Canada and the United States to date. The research programs, recent results, and link of these results to previous results are summarized. The experimental data and calibrated linear and nonlinear damage accumulation models are presented. Finally, two approaches to developing load duration factors—the traditional stress ratio approach and a probabilistic approach—are discussed.

15. Ultimate Tensile Stress and Modulus of Elasticity of Fast-Grown Plantation Loblolly Pine Lumber

Kretschmann, David E.; Bendtsen, B. Alan.
1992. Wood Fiber Sci. 24(2): 189-203.

The purpose of this study was to define the influence of juvenile wood on the tensile structural performance of dimension lumber from fast-grown plantation pine wood. Ultimate tensile stress and modulus of elasticity were measured on nominal 2- by 4-in. (standard 38- by 89-mm) lumber from a 28-year-old fast-grown loblolly pine plantation in North Carolina. Four grades of lumber and two lumber lengths were compared.

16. The Mormon Creek Bridge: Performance After Three Years

McCutcheon, William J.
1992. USDA Forest Serv. Res. Pap. FPL-RP-509. 8 p.

This report describes the construction and performance of a single-lane, experimental, parallel-chord, stress-laminated bridge, the Mormon Creek Bridge. The development, analysis, testing, and construction of stress-laminated, parallel-chord bridges are further described in another Forest Products Laboratory report, Behavior of Stress-Laminated Parallel-Chord Timber Bridge Decks: Experimental and Analytical Studies (in press).

17. Contribution of Flake Alignment to Performance of Strandboard

McNatt, J. Dobbin; Bach, Lars; Wellwood, Robert W.
1992. Forest Prod. J. 42(3): 45-50.

The objective of this research was to compare the behavior of strandboards with face strands aligned and core strands random, face and core cross alignment, and unidirectional alignment with that of non-aligned homogeneous panels made with the same furnish, resin type, and resin content.

18. Rheological Properties of Chemically Modified Wood: Relationship Between Dimensional and Creep Stability

Norimoto, Misato; Gril, Joseph; Rowell, Roger M.
1992. Wood Fiber Sci. 24(1): 25-35.

The purpose of this research was to characterize the ability of a chemical treatment to stabilize mechanosorptive creep. To do this, an anti-creep efficiency (ACE) factor was obtained through a 4-day creep-recovery bending test. Spruce wood was subjected to 14 chemical treatments, and anti-swelling or shrinkage efficiency, ACE, and other conventional strength properties were measured and compared. Based on the data obtained, a simple molecular model is proposed to account for both moisture expansion and mechanosorptive creep of wood. A typology of chemical treatments based on this model is suggested.

19. Using Today's Technology to Help Preserve USS *Constitution*

Witherell, Peter W.; Ross, Robert J.; Faris, William R.
1992. Naval Engineers J. May: 124-134.

To retain as much of the USS *Constitution*'s remaining original material as possible, and at the same time preserve the ship's hull form and structural integrity for the future, the Navy has conducted numerous inspections and engineering studies over the past decade. While much of this work has involved visual inspections, test borings, mechanical testing, classical naval architecture calculations, and research into past shipbuilding practices, a commeasurate amount of effort has also been directed at using today's technology to maximum advantage. This paper discusses: (1) inspecting the ship's fasteners using

ultrasonic testing, (2) inspecting the ship's wooden structure using three nondestructive test methods, (3) analyzing ship deflections and general stress level using finite element modeling on a computer, and (4) investigating the use of fiber reinforced composites to strengthen the ship.

20. Test Apparatus for Simulating Interactive Loads on Metal Plate Wood Connections

Wolfe, Ronald W.; Hall, Michael; Lyles, DeAndrea.
1991. J. Test. Eval., JTEVA. 19(6): 421-428.

This paper discusses the design and evaluation of an apparatus for testing metal plate connector joints in nominal 2- by 4-in. (standard 38- by 89-mm) lumber. This apparatus can be easily fabricated and adapted to several testing machines.

21. New Column Design Formula

Zahn, John J.
1991. Wood Design Focus. Summer: 10-12.

The old column formulas of the 1986 *National Design Specification for Wood Construction* are compared with the new 1991 column formulas. The new design method is considered to be more conservative; a change that is necessitated by recent column test data. It will also be better able to accommodate future changes in the wood resource base and the introduction of new wood products because it has an adjustable parameter that models degrees of homogeneity and straightness.

Fiber and Particle Products

22. Response of Flakeboard Properties to Changes in Steam Injection Pressing Environments

Geimer, Robert L.; Johnson, Stephen E.; Kamke, Frederick A.
1991. USDA Forest Serv. Res. Pap. FPL-RP-507. 22 p.

Mechanical strength properties and dimensional stability of composite wood products are determined to some extent by the environment within the mat during pressing. The objectives of this study were to define time-related temperature and vapor-pressure parameters occurring in a mat during different steam injection pressing schedules and to relate these conditions to board properties.

23. Cost Function Approach for Estimating Derived Demand for Composite Wood Products

Marcin, Thomas C.
1991. In: Proceedings of the 1991 symposium on systems analysis in forest resources; 1991 March 3-6; Charleston, SC. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 225-240.

A cost function approach was examined for using the concept of duality between production and input factor demands. A translog cost function was used to represent residential construction costs and derived conditional factor demand equations. Alternative models were derived from the translog cost function by imposing parameter restrictions.

24. Composites From Recycled Materials

Rowell, Roger M.; Youngquist, John A.; McNatt, Dobbin.
1991. In: Maloney, T.M., ed. Proceedings of the 25th International particleboard/composite materials symposium; 1991 April 9-11; Pullman, WA. Pullman, WA: Washington State University: 301-314.

A reduction is urgently needed in the quantities of industrial and municipal solid waste materials that are being landfilled. Major components of municipal solid waste include waste wood, paper, plastics, fly ash, gypsum, and other biomass fibers—materials that offer great opportunities as recycled ingredients in wood composites. This paper discusses possibilities for manufacturing selected composites from these materials. Methods for producing the composites and the resultant product properties and attributes are described. Research and development needs for maximizing the benefits of using recovered waste materials for composite products are discussed.

25. Dimensional Stability of Aspen Fiberboard Made From Acetylated Fiber

Rowell, Roger M.; Youngquist, John A.; Rowell, Jeffrey S.; Hyatt, John A.
1991. Wood Fiber Sci. 23(4): 558-566.

The objectives of this research were (1) to determine if aspen fiber can be acetylated using ketene gas, (2) to compare moisture sorption properties of fiberboards made from fiber acetylated by ketene and acetic anhydride reactions, and (3) to determine the dimensional stability and mechanical properties of control and acetylated fiberboards.

26. HCHO Emissions Debate Invites Scrutiny of Lab Tests, Economics

Spelter, Henry
1992. Panel World. March: 22-24.

This article reviews the main points of contention between regulators and producers of formaldehyde. Discussions are ongoing, and positions attributed to Environmental Protection Agency are not final.

Fire Safety

27. Charring Rate of Wood for ASTM E 119 Exposure

White, Robert H.; Nordheim, Erik V.
1992. Fire Technol. 28(1): 5-30.

The overall objective of this work was to understand the important factors affecting the variability in fire performance of different wood species. The specific objective was to develop empirical models that predict the species difference in charring rates in terms of basic wood characteristics and that are applicable for all species.

Microbial and Biochemical Technology

28. Biomechanical Pulping of Loblolly Pine With Different Strains of the White-Rot Fungus *Ceriporiopsis subvermispora*

Akhtar, Masood; Attridge, Michael C.
1992. Tappi J. February: 105-109.

The objectives of this study were to evaluate biomechanical pulping of loblolly pine as a means of reducing consumption of electrical energy and improving paper strength properties.

29. Evaluation of Methods to Extract Ergosterol for Quantitation of Solid Fungal Biomass

Davis, Mark W.; Lamar, Richard T.
1992. Soil Biol. Biochem. 24(3): 189-198.

Two methods were evaluated to extract ergosterol for quantitation of fungal biomass in Marshan, Zurich, and Batavia soils. Yields of ergosterol from hyphae and from fungal-colonized soil were greater when fungal tissue was extracted with an alkaline solvent mixture than when base was added to neutral extracts following removal of solids. A lyophilization treatment prior to extraction increased yields from Marshan but not from Zurich and Batavia soils. Losses of ergosterol during lyophilization were prevented by a rapid freezing treatment before lyophilization of soil samples. Recoveries from soil fortified with pure ergosterol did not accurately model recoveries from fungal tissue in these substrates. Thus, determinations of extraction efficiencies should be based upon recoveries from fungal tissue added to soils. Ergosterol was quantitatively recovered from Marshan and Zurich soils fortified with fungal tissue; however, only about 66 percent was recovered from Batavia soil, a subsoil with a high clay content. The limit of detection of *Phanerochaete chrysosporium* from the three soils ranged from 8 to 15 μg biomass g soil^{-1}.

Oxidative Degradation of Phenanthrene by the Ligninolytic Fungus *Phanerochaete chrysosporium*

Hammel, Kenneth E.; Gai, Wen Zhi; Green, Benita; Moen, Mark A.
1992. Appl. Environ. Microbiol. June: 1832-1838.

Available from Institute for Microbial and Biochemical Technology, Building 34, Room 108, Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, One Gifford Pinchot Drive, Madison, WI 53705-2398 USA. No charge.

The ligninolytic fungus *Phanerochaete chrysosporium* oxidized phenanthrene and phenanthrene-9,10-quinone (PQ) at their C-9 and C-10 positions to give a ring-fission product, 2,2′-diphenic acid (DPA), which was identified in chromatographic and isotope dilution experiments. DPA formation from phenanthrene was somewhat greater in low-nitrogen (ligninolytic) cultures than in high-nitrogen (nonligninolytic) cultures and did not occur in uninoculated cultures. The oxidation of PQ to DPA involved both fungal and abiotic mechanisms, was unaffected by the level of nitrogen added, and was significantly faster than the cleavage of phenanthrene to DPA. Phenanthrene-*trans*-9,10-dihydrodiol, which was previously shown to be the principal phenanthrene metabolite in nonligninolytic *P. chrysosporium* cultures, was not formed in the ligninolytic cultures employed here. These results suggest that phenanthrene degradation by ligninolytic *P. chrysosporium* proceeds in order from phenanthrene → PQ → DPA, involves both ligninolytic and nonligninolytic enzymes, and is not initiated by a classical microsomal cytochrome P-450.

Ring Fission of Anthracene by a Eukaryote

Hammel, Kenneth E.; Green, Benita; Gai, Wen Zhi.
1991. In: Proceedings, National Academy of Science. 88: 10605-10608. December.

Available from Institute for Microbial and Biochemical Technology, Building 34, Room 108, Forest Products Laboratory, Forest Service, U.S. Department of Agriculture, One Gifford Pinchot Drive, Madison, WI 53705-2398 USA. No charge.

Ligninolytic fungi are unique among eukaryotes in their ability to degrade polycyclic aromatic hydrocarbons (PAHs), but the mechanism for this process is unknown. Although certain PAHs are oxidized *in vitro* by the fungal lignin peroxidases (LiPs) that catalyze ligninolysis, it has never been shown that LiPs initiate PAH degradation *in vivo*. To address these problems, the metabolism of anthracene (AC) and its *in vitro* oxidation product, 9,10-anthraquinone (AQ), was examined by chromatographic and isotope dilution techniques in *Phanerochaete chrysosporium*. Results show that the major pathway for AC degradation in *Phanerochaete* proceeds AC→ AQ→ phthalate + CO_2 and that it is probably mediated by LiPs and other enzymes of ligninolytic metabolism.

30. Enzymatic Treatments of Pulps

Jeffries, Thomas W.
1992. Materials and chemicals from biomass. ACS Symposium Series No. 476. Washington, DC: American Chemical Society: 313-329.

Examples of enzymatic treatments of pulps are provided and their efficacy is discussed. Most of the information has been obtained from patents and from the proceedings of specialized meetings. Relatively few studies have been published in refereed journals.

31. Changes in Molecular Size Distribution of Cellulose During Attack by White Rot and Brown Rot Fungi

Kleman-Leyer, Karen; Agosin, Eduardo; Conner, Anthony H.; Kirk, T. Kent.
1992. Appl. Environ. Microbiol. April: 1266-1270.

The purpose of this study was to compare the kinetics of cellulose depolymerization by brown and white rot fungi in the solid-state system. The ultimate goal is to understand the chemistry and biochemistry involved in cellulose depolymerization by brown rot fungi.

32. White-Rot Fungi Biodegradation of PCP-Treated Ammunition Boxes

Lamar, Richard; Scholze, Richard J.
1992. Explosives and Munitions Handling. In: Proceedings of R&D 92 National research and development conference on the control of hazardous materials; 1992 February 4-6; San Francisco, CA. Greenbelt, MD: Hazardous Materials Control Resources Institute: 89-94.

The objectives of this study were (1) to determine the fate of pentachlorophenol (PCP) in chips inoculated with *Trametes hirsuta* and (2) to identify the factors that are important for scaleup of the fungal disposal of PCP-treated wood using *T. hirsuta*.

33. Application of Modern Liquid-State NMR to Lignin Characterization. I. One-Dimensional Spectral Editing Techniques

Landucci, Lawrence L.
1991. Holzforschung. 45(Suppl. 55-60): 55-60.

Spin-echo (JMOD, APT, and QUAT) and polarization-transfer (DEPT and INEPT) nuclear magnetic resonance (NMR) experiments were compared and evaluated for the ^{13}C NMR characterization of lignins. A combination of experiments was advantageous for optimal information content, especially in the assignment of weak signals. Details concerning the implementation of the various experiments and their advantages and disadvantages are described.

34. Incorporation of ρ-Cresol Into Lignins via Peroxidase-Catalysed Copolymerization in Nonaqueous Media

Popp, Janet L.; Kirk, T. Kent; Dordick, Jonathan S.
1991. Enzyme Microb. Technol. 13: 964-968.

Lignin, the second most abundant biopolymer after cellulose, is a low-value byproduct of agricultural and wood conversion processes, including wood pulp manufacture. Copolymerization with phenols has the potential to convert byproduct lignins to higher value phenolic resins. In this initial investigation, the authors studied the use of horseradish peroxidase in aqueous dioxane to catalyse the grating of ρ-cresol (ρ-methylphenol) onto milled wood lignin, kraft lignin, and a lignin selectively o-demethylated by a brown-rot fungus.

35. Limited Bacterial Mineralization of Fungal Degradation Intermediates From Synthetic Lignin

Rüttimann; Vicuña, Rafael; Mozuch, Michael D.; Kirk, T. Kent.
1991. Appl. Environ. Microbiol. 57(12): 3652-3655.

The ability of selected bacterial strains and consortia to mineralize degradation intermediates produced by *Phanerochaete chrysosporium* from ^{14}C-labeled synthetic lignins was studied. Three different molecular weight fractions of the intermediates were subjected to the action of the bacteria, which had been grown on a lignin-related dimeric compound.

Mycology

36. Isozyme Analysis in Fungal Taxonomy and Molecular Genetics

Micales, J.A.; Bonde, M.R.; Peterson, G.L.
1992. In: Arora, Dilip K.; Elander, Richard P.; Mukerji, K.G., eds. Handbook of applied mycology. Vol. 4, Fungal biotechnology. New York: Marcel Dekker, Inc.: 57-79.

Isozyme analysis is a powerful technique that has many applications in plant pathology and mycology. For years, its use was restricted to studies in fungal taxonomy, often with ambiguous results. Concurrently, geneticists were using this procedure to examine the population genetics of fish, mammals, insects, nematodes, and plants. Isozyme analysis is now used by mycologists to resolve taxonomic disputes, identify unknown fungal taxa, "fingerprint" patentable fungal lines, analyze the amount of genetic variability in a population, trace the origin of pathogens, follow the segregation of loci, and identify ploidy levels throughout the life cycle of an organism. This topic has been previously reviewed, but the many advances in recent years necessitate the revision found in this article.

Processing of Wood Products

37. Quality Drying of Hardwood Lumber: Guidebook-Checklist

Boone, R. Sidney; Milota, Michael R.; Danielson, Jeanne D.; Huber, Dean W.
1991. USDA Forest Serv. Res. Pap. FPL-IMP-GTR-2. 56 p.

The IMPROVE Lumber Drying Program is intended to increase awareness of the lumber drying system as a critical component in the manufacture of quality lumber. One objective of the program is to provide easy-to-use tools that a kiln operator can use to maintain an efficient kiln operation and therefore improve lumber drying quality. This report is one component of the IMPROVE Program. It contains a Guidebook-Checklist for Quality Drying of Hardwood Lumber that kiln operators or owners can use to readily evaluate how well their operations rate on those factors that most strongly affect drying quality, with particular emphasis on kiln operation and maintenance and lumber handling. Appendix 1 contains a shortened version of the checklist for easy duplication and filing. Appendix 2 contains the same checklist items; however, the information is arranged by drying system components for convenience in checking individual components.

38. Effects of Ultrasonic Cavitation on Rate of Heat Propagation and Longitudinal Permeability of Three U.S. Hardwoods

Chen, Peter Y.S.; Simpson, William T.
1992. Forest Prod. J. 42(4): 55-58.

Exploratory research investigated the feasibility of using ultrasonic cavitation to improve the heartwood permeability of three central U.S. hardwoods, to explain how heat propagates in wood under ultrasonic cavitation, and to examine the relation, if any, between the rate of heat propagation and wood permeability.

39. Industrial Trials of Low-Expansivity Sawblades

Danielson, Jeanne D.; Worzala, Frank J.
1992. In: Lemaster, Richard L., ed. Proceedings of 10th International wood machining seminar; 1991 October 21-23; Berkeley, CA. Berkeley, CA: University of California: 202-209

Low-expansivity alloys have the potential to reduce thermal instability of sawblades during the sawing operation. In preliminary industrial trials of sawblades made of low-expansivity alloy, sawing

accuracy was improved 22 to 38 percent during normal sawing. When saws made of a low-expansivity alloy were operated with a large temperature gradient across the blade, sawing accuracy was comparable to that of steel saws operated with little temperature gradient.

40. A Parametric Study of Heat and Mass Transfer in Drying of Capillary-Porous Media

Liu, Jen Y.; Cheng, Shun.
1991. Multiphase transport in porous media. FED-Vol. 122/ HTD-Vol. 186. American Society for Testing and Materials: 25-32.

This paper evaluates the relative importance of the dimensionless numbers in the Luikov system of heat and mass transfer equations in predicting the temperature and moisture distributions in capillary-porous media during drying. The six dimensionless numbers considered are the Lukomskii number Lu, Biot heat transfer number Bi_q, Biot mass transfer number Bi_m, phase transformation number ε, Posnov number Pn, and Kossovich number Ko. The thermophysical properties of spruce were used to derive the reference set of input data for the dimensionless numbers. By varying each of the six numbers twice while keeping the others constant, 13 sets of input data were generated. The Fourier number, also defined as dimensionless time, covered the range of interest. The solution technique applied is somewhat simpler than those reported by others in the literature.

41. Identifying Bacterially Infected Oak by Stress Wave Nondestructive Evaluation

Ross, Robert J.; Ward, James C.; TenWolde, Anton.
1992. USDA Forest Serv. Res. Pap. FPL-RP-512. 6 p.

Bacterially infected wood, called wetwood, is often not visually apparent in logs or green lumber. When kiln dried, lumber containing wetwood is prone to develop costly defects. The objective of this study was to determine the effectiveness of a stress wave nondestructive evaluation technique to detect the presence of wetwood, thereby allowing separation of bacterially infected and noninfected lumber before kiln drying.

42. Press-Drying Plantation Loblolly Pine Lumber to Reduce Warp: Follow-Up Studies

Simpson, William T.; Pearson, Ronald G.; Tang, Yifu.
1992. Forest Prod. J. 42(5): 65-69.

Results of two follow-up studies on the effectiveness of press-drying in reducing warp and grade loss from warp in plantation-grown loblolly pine lumber were compared with results of a previously published study. The results showed that press-drying does reduce warp and resultant grade loss, when compared to high-temperature kiln-drying in a laboratory dry kiln. When the most favorable press variables were used, grade loss from warp was reduced by more than 50 percent.

Pulp, Paper, and Packaging

43. Reclaiming Fiber From Newsprint Dry Methods

Gunderson, Dennis E.; Scott, C. Tim; Gleisner, Rollie L.
1992. J. Hazard. Mater. 29: 297-311.

In this paper, three experiments are reported: two are related to mechanical fiberizing of dry or semidry newsprint, and the third describes progress in the production of a newsprint-weight handsheet by an air-forming technique. These experiments describe the "road not taken" in prior developments. The work has not been highly successful, but concepts and processes that may make urban conversion of old newspapers to newsprint not only feasible but highly attractive may yet exist.

44. Projected Impacts on Southern Timber Markets of Accelerated Paper Recycling

Ince, Peter J.
1991. In: Proceedings of the southern forest economics workshop on environmental concerns, government regulations, new technology and their impact on southern forestry; 1991 February 20-22; Washington, DC. Baton Rouge, LA: Louisiana State University: 115-124.

Long-range projections were obtained from the same set of economic models used by the Forest Service in the 1989 Research Planning Assessment (RPA) Assessment. This paper includes projections made after the 1989 RPA Assessment document was published, but all projections are from the same set of economic models (with adjustments in assumptions to simulate different scenarios).

45. Feasibility of Recycling Post-Consumer Diapers

Klungness, John H.; Siegfried, Robert H.
1992. Progress in Paper Recycling. May: 49-59.

This report presents some results of the pilot demonstration study at the Rabanco Recycling Company. The Forest Products Laboratory (FPL) was involved with two aspects of this study. First, the FPL conducted exploratory experiments for selecting separation equipment for the Rabanco pilot study. Second, after the pulp was recovered at the Rabanco demonstration plant and the recovery process was assessed, FPL studied the effectiveness of various cleaners in removing contaminants from the reclaimed pulp.

46. Application of Modern Liquid-State NMR to Lignin Characterization. 2. ^{13}C Signal Resolution and Useful Techniques

Landucci, Lawrence L.
1991. Holzforschung. 45(6): 425-432.

The purposes of this study were to determine (1) optimal methods for enhancing the resolution of lignin spectra, (2) limiting aspects of field strength on signal dispersion and resolution, and (3) the optimal signal resolution that may be expected under various conditions.

47. The ^{1}H and ^{13}C NMR Spectra of the Abietadienoic Resin Acids

Landucci, L.L.; Zinkel, D.F.
1991. Holzforschung. 45(5): 341-346.

The ^{13}C and ^{1}H NMR spectra of the methyl esters of the common diterpene abietadienoic resin acids were interpreted. The ^{13}C and ^{1}H chemical shifts were assigned by a combination of one-dimensional methods (such as conventional proton decoupling, NOE difference, and DEPT) and two-dimensional experiments such as short- and long-range carbon-proton correlation.

48. Effects of Composition and Polypropylene Melt Flow on Polypropylene—Waste Newspaper Composites

Myers, G.E.; Clemons, C.M.; Balatinecz, J.J.; Woodhams, R.T.
1992. In: Proceedings of the 1992 annual conference of the Society of Plastics Engineers (SPE/ANTEC); 1992 May 3-7; Detroit, MI. Brookfield, CT: Society of Plastics Engineers: 602-604. Vol. 1

Recently, a program was initiated by the Forest Products Laboratory, the University of Toronto, and others in cooperation with the Wisconsin Department of Natural Resources to establish the commercial feasibility of extruded or injection-molded composite products from polypropylene and old newspaper. This report summarizes the mechanical properties of the composites.

49. Wood Sugar Analysis by Anion Chromatography

Pettersen, Roger C.; Schwandt, Virgil H..
1991. J. Wood Chem. Technol. 11(4): 495-501.

This report concerns the results obtained from standard wood and wood-pulp samples using anion-exchange liquid chromatography and pulsed amperometric detection.

50. A Variation in Acid-Catalyzed Isomerization of Abietadienoic Acids

Zinkel, Duane F.
1991. J. Wood Chem. Technol. 11(4): 439-446.

Heating the individual common abietadienoic acid methyl esters with p-toluene sulfonic acid in chloroform led to the formation of methyl abietadienoates other than the equilibrium mixture of methyl abietate, palustrate, and neoabietate that is usually formed by acid-catalyzed isomerization. Of these other methyl abietadienoates, the three principal constituents comprised 10, 4, and 2 percent of the monomers; these compounds were isolated and identified as methyl 13β-abieta-7,9(11)-dien-18-oate, methyl 7,9(11)-abietadien-18-oate, and methyl 8,12-abietadien-18-oate, respectively.

Timber Requirements and Economics

51. Multivariate Stochastic Simulation With Subjective Normal Distributions

Ince, Peter J.; Buongiorno, Joseph.
1991. In: Proceedings of the 1991 symposium on systems analysis in forest resources; 1991 March 3-6; Charleston, SC. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station: 143-150.

Stochastic simulation is a practical approach to prediction because estimating a likelihood distribution for many variables in a model is often easier than estimating their precise values. In this paper, the classical stochastic (Monte Carlo) simulation techniques are reviewed, then a method is suggested to take into account the subjective correlations among variables, validate the method, and apply it to a specific case study.

52. Timber Products Used to Build U.S. Single-Family Houses in 1988

McKeever, David B.; Anderson, Robert G.
1992. Forest Prod. J. 42(4): 11-18.

This paper presents results from a cooperative study conducted by the USDA Forest Service, Forest Products Laboratory, and the Wood Products Promotion Council. The types and quantities of timber products used to build all styles of new single-family houses in the United States in 1988 are estimated by region, building system and application, and wood product. In addition, estimates are presented of lumber, structural panels, and nonstructural panels that are used in floor, wall, and roof systems, in garages, porches, and decks, and in millwork and miscellaneous uses for new single-family houses built in the North, South, and West regions of the United States.

53. Labor Demand by Forest Products Industries: A Review

Vincent, Jeffrey R.; Lange, William J.; Seok, Hyun-Deok.
1992. USDA Forest Serv. Res. Pap. FPL-RP-510. 13 p.

The impact of labor on the forest products industry is generally analyzed by input-output models, which do not take into account such economic variables as wage rates, scale of production, and technical change. The aim of this paper is to summarize results from econometric research that pertain to labor demand. The paper reviews major microeconomic relationships (elasticities), describes principal empirical approaches used to estimate elasticities, and summarizes statistical estimates drawn from the literature. The final section discusses implications for policy analysis and suggests future research directions.

Wood Bonding Systems

54. Fungal Resistance of Loblolly Pine Reacted With Para-Toluene Sulfonyl Chloride or Isocyanate

Chen, George C.
1992. Wood Fiber Sci. 24(2): 161-167.

The purpose of this study was to bond para-toluene sulfonyl chloride or para-toluene sulfonyl isocyanate to wood and to determine the fungal decay resistance of these modified woods.

55. Mechanical Interlocking of Adhesive Bonds to CCA-Treated Southern Pine—A Scanning Electron Microscopic Study

Vick, Charles B.; Kuster, Thomas A.
1992.Wood Fiber Sci. 24(1): 36-46.

New adhesively bonded products made from lumber, veneer, flakes, and fibers that are protected from biological deterioration can play a prominent role in the marketplace if difficulties in bonding preservative-treated wood can be overcome. The purpose of this study was to demonstrate that bonds of extraordinary integrity can be developed in Southern Pine treated with chromated copper arsenate preservative, if a durable adhesive penetrates enough to mechanically interlock within the cellular structure of the wood.

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